Abstract of PhD Thesis "Distributed Algorithms for Power Allocation Games on Gaussian Interference Channels"

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We consider a wireless communication system in which there are N transmitter-receiver pairs and each transmitter wants to communicate with its corresponding receiver. This is modeled as an interference channel. We propose power allocation algorithms for increasing the sum rate of two and three user interference channels. The channels experience fast fading and there is an average power constraint on each transmitter. In this case receivers use successive decoding under strong interference, instead of treating interference as noise all the time.
Next, we use game theoretic approach for power allocation where each receiver treats interference as noise. Each transmitter-receiver pair aims to maximize its long-term average transmission rate subject to an average power constraint. We formulate a stochastic game for this system in three different scenarios. First, we assume that each user knows all direct and cross link channel gains. Next, we assume that each user knows channel gains of only the links that are incident on its receiver. Finally, we assume that each user knows only its own direct link channel gain. In all cases, we formulate the problem of finding the Nash equilibrium (NE) as a variational inequality (VI) problem. For the game with complete channel knowledge, we present an algorithm to solve the VI and we provide weaker sufficient conditions for uniqueness of the NE than the sufficient conditions available in the literature. Later, we present a novel heuristic for solving the VI under general channel conditions. We also provide a distributed algorithm to compute Pareto optimal solutions for the proposed games. We use Bayesian learning that guarantees convergence to an ϵ-Nash equilibrium for the incomplete information game with direct link channel gain knowledge only, that does not require knowledge of the power policies of other users but requires feedback of the interference power values from a receiver to its corresponding transmitter.
Later, we consider a more practical scenario in which each transmitter transmits data at a certain rate using a power that depends on the channel gain to its receiver. If a receiver can successfully receive the message, it sends an acknowledgement (ACK), else it sends a negative ACK (NACK). Each user aims to maximize its probability of successful transmission. We formulate this problem as a stochastic game and propose a fully distributed learning algorithm to find a correlated equilibrium (CE). In addition, we use a no regret algorithm to find a coarse correlated equilibrium (CCE) for our power allocation game. We also propose a fully distributed learning algorithm to find a Pareto optimal solution. In general Pareto points do not guarantee fairness among the users. Therefore we also propose an algorithm to compute a Nash bargaining solution which is Pareto optimal and provides fairness among the users. Finally, we extend these results when each transmitter sends data at multiple rates rather than at a fixed rate.